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Title

~~Vehicle Data Recorder~~

6 SU FIELD OF THE INVENTION

7 This invention in general relates to vehicle data recorders. More specifically,
8 the invention is a vehicle data recorder using microprocessor controlled electronics a
9 two stage random access memory, and a non-volatile memory to retain the vehicle
10 identification number and data on impact forces, brake activation, seat belt use,
11 vehicle speed, vehicle direction, vehicle rollover, and the date and time of the incident.

12 BACKGROUND OF THE INVENTION

13 PRIOR ART

14 In 1997, the most recent year for which data is available, there were 6,764,000
15 police reported accidents according to the National Highway safety Board. These
16 accidents caused an estimated \$150,000,000,000.00 in economic losses and about
17 47,000 lives. This invention, hereinafter referred to as the Vehicle Data Recorder, or
18 "VDR" is designed to save lives and money by providing instant access to critical
19 information about a motor vehicle accident.

20 The VDR is unique because it is a self-contained modular unit easily installed
21 on any motor vehicle. It will monitor and record data on eight data channels, three
22 from internal event triggered sensors, one from an internal electronic compass, and
23 four ^{from} ~~from~~ the host vehicle. The data will be stored in memory in a time correlated file
24 format which upon power interruption, will be transferred to permanent data storage,
25 where it will be available for download to any ^W ~~W~~ [®] windows based computer via a serial
26 connection.

27 Consider the following example. A squad is called to the scene of a single car
28 motor vehicle. The patient is unconscious and unable to tell the paramedics what

happened. The paramedics would treat this patient for obvious visible life threatening injuries and transport him to the nearest trauma center. The trauma center would try to stabilize the patient and start test to determine the extent of the patient's injuries. With access to the type of information provided by this invention, you would know the vehicle identification number and that the vehicle was involved in a head on collision on June 9, 1998 at 7:57:35PM . You would know that the vehicle was traveling at 47.5mph at the time of the 10g collision and that the driver had swerved 30 degrees to his left and applied his brakes exactly .3 sec prior to the crash and that he had been wearing his seatbelt.

Instant access to this type of detailed information will allow EMS and subsequently hospital personnel to focus attention and resources upon the most serious and life threatening injuries. It will also start the clock on the "Golden Hour" with a time certain, thus encouraging a quicker decision for a load and go situation.

Medical personnel would not be the only group interested in this data. The following would have at least as much interest in this information as well.

1. Police.
2. Insurance Companies.
3. State and Federal Government agencies.
4. Automotive companies.

The foundation upon which all accident investigations is built is the written report compiled by the police officers at the scene. This report contains a variety of information, some of it based upon observation, such as, road and weather conditions, or hazardous environmental or construction obstacles that might have contributed to the accident. The balance of the report is comprised of estimation, hearsay, or calculation, I.E. the speed of the vehicle, was the seatbelt fastened, how hard and where was the initial impact, and did a rollover occur.

The availability of an electronic accident report coded with the vehicle

56 identification number for vehicle identification and containing precise information
57 about a motor vehicle accident would allow the insurance companies to create a more
58 accurate database from which actuarial calculations could be made. More accurate
59 calculations would lead to a more equitable distribution of risk and therefore rates
60 could be based upon car and driver records that would be more accurate than
61 anything currently available. Government involvement in highway safety has always
62 had the dual aim of saving lives, and reducing the enormous economic losses
63 attributed to motor vehicle accidents. To this end they have maintained a data base
64 on all motor vehicle accidents reported to them by the police. The electronic accident
65 report will provide precise information from which to build a data base.

66 Vehicle data recorders have been the subject of earlier patents and
67 often they have included inputs from brake pedal travel, accelerator position, turn
68 signals, headlights, acceleration forces, and some have even included video inputs.
69 Most vehicle data recorders, however, have concentrated on a static laboratory
70 environment and staged accidents using specifically designed test vehicles. Data
71 collection devices used on these test vehicles are expensive and sophisticated. Some
72 of these devices include:

- 73 1. Gyroscopic devices.
- 74 2. Laser devices.
- 75 3. Video cameras.
- 76 4. Impact sensors.
- 77 5. Accelerometers.

78 The advantages and disadvantages of these devices in a real-world
79 environment are as follows. Gyroscopic devices have proved themselves to be
80 effective and accurate in a laboratory test vehicle, and in aircraft inertial navigation
81 systems. They are, however, expensive, require a relatively long warm up period
82 before stabilization can occur, and they consume a relatively large amount of power.

83 In fact the power consumption of a gyroscopic device would require a complete re-
84 design of the typical motor vehicle electrical system. Lasers also consume large
85 amounts of power and are limited to being a reference from which to measure vehicle
86 distortion after an impact. Video cameras, are now being used in some vehicles as
87 stand alone data collection devices, but the cameras focus will always be on the
88 outside events. Specialized impact sensors, and accelerometers fall into the same
89 broad category. They each have a function in a staged accident, but are not of any
90 beneficial use in the real world unless coupled with a more encompassing system like
91 the Vehicle Data Recorder.

92 Aviation has developed data collection devices that are unique to the
93 demanding aspects of aviation. Flight Data Recorders have proved invaluable to the
94 National Transportation and Safety Board when they had to investigate accidents.
95 The unique and challenging nature of flight, and the tremendous forces that occur in
96 an airplane crash, have contributed to the development of a very sophisticated
97 recorder that is coupled to all essential operating systems in an aircraft that will
98 withstand the tremendous forces of an airplane crash. The system is very expensive,
99 in fact is so expensive that it is not even used in private aircraft. Several real world
100 events and advances in technology first led me to conceive of the Vehicle Data
101 Recorder. The three events are the car crash that killed princess DI, and the inability
102 of the police to determine exactly what happened. An airplane crashed in Okinawa,
103 and I was on an emergency call to an automobile accident where the hospital ask me a
104 series of questions about the accident to try to determine the mechanism of injury.
105 The technological advances in computer hardware, specifically faster and cheaper
106 microprocessors, and the larger capacity storage devices developed within the past
107 two years led me to believe that they might be utilized in such a way as to answer my
108 questions about mechanism of injury.

109 The purpose of the Vehicle Data Recorder, therefore is to provide an

110 economical and reliable means to collect essential real world data about how a vehicle
111 behaves during an accident.

112 Following is a summary of relevant vehicle data recorder patents. ~~A more complete~~
113 ~~list is included in the appendix.~~

114 1. Decker et al patent # 4,533,962.

115 A method and apparatus for sensing and recording diverse operational and
116 performance characteristics of automotive vehicles and the like has a plurality of
117 transducers directly associated with different mechanical functions of the vehicle for
118 sensing their operating characteristics in relation to time as well as generating analog
119 signals representative of certain functions and combining them with digital signals
120 representing other functions. A signal converter encodes signals from the transducers
121 in predetermined order into digital data signals. Each succession of signals generated
122 are temporarily stored. A recorder then records information stored serially and
123 enables ready access to and identification of each event or condition. After
124 recordation of information over a selected time interval, the recording is automatically
125 erased as additional information is transmitted to the recorder to provide a current
126 history over limited time intervals, such as 30 minutes so as to be especially useful in
127 accident analysis.

128 The Decker recorder provides a method for sensing and recording numerous
129 operational and performance characteristics of a host vehicle. The Decker system is
130 based on the placement of numerous transducers throughout the host vehicle and
131 associating the electro-mechanical output of the transducer with the specific vehicle
132 system such as brake pedal travel, and wheel rotation to determine speed. The
133 recorder portion of the system writes to a continuous tape loop discrete blocks of
134 data representing vehicle operation.

135 2. Zottnik, patent # 4,638,289

136 An accident data recorder for short-time recordation and storage of data and

137 events relating to an accident of motor vehicles, comprising pickups for sensing, for
138 example, wheel revolutions to determine the traveled distance and speed of the
139 vehicle. In addition to these wheel sensors, capacitance-based acceleration sensors
140 are provided whose output signals along with the output signals of the wheel sensors
141 and with other status data relating to the operation of the vehicle, are continuously
142 recorded at storage locations of a fixed storage. For this purpose, an addressing logic
143 is provided which operates in a closed counting loop and, as soon as a final address is
144 reached jumps back to the starting address to overwrite the initially stored data. The
145 cyclic data storage is interrupted by the occurrence of a trigger event defining an
146 accident, with the result that the last recorded data, including a predetermined after-
147 travel time, are frozen.

148 The Zottnik device is basically a short duration recorder that receives input
149 from various sensors located around the host vehicle and uses an addressing logic
150 which operates in a closed counting loop to store data until the final address is
151 reached, at which time it jumps back to the beginning and writes over the previously
152 stored data. When a trigger event occurs such as a vehicle accident the data in
153 storage is permanently stored for later analysis.

154 3. Takeuchi et al patent # 4,866,616

155 Vehicle information such as vehicle speed, engine rotation speed when a
156 vehicle runs are collected and converted into numerical data every constant period of
157 time and these numerical data are written and recorded into memory module. The
158 memory module has therein a non-volatile memory and is detachably provided to a
159 write unit attached to the vehicle. The data writing and power supply to the memory
160 module from the write unit are executed by the contactless coupling using induction
161 coils.

162 The Takeuchi recorder concentrates on inputs such as vehicle speed and
163 engine rotation and is thus able to concentrate on information as it relates to drive

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164 times, drive distances, vehicle speed, and engine rotation. The information is
 165 gathered from using electromagnetic induction coils to sense the desired information
 166 and relay it to the module where it is recorded into memory.

167 4. McCracken patent# 4,992,943

168 An invention which facilitates motor vehicle accident reconstruction by
 169 providing apparatus for detecting and storing data describing the status of a motor
 170 vehicle when it is involved in a collision. The invention includes a plurality of impact
 171 detectors, a microprocessor which obtains vehicle status data from the computer
 172 systems used in modern vehicles, and a memory, such as an EPROM, for storing data
 173 for later retrieval.

174 The McCracken recorder uses the vehicles onboard computer as its' source of
 175 data. The obtained data is not stored in memory until one of the many impact
 176 sensors located throughout the host vehicle triggers and event. The vehicle status is
 177 then stored in an EPROM non-volatile memory for later retrieval and analysis. The
 178 chief failing of the Mckracken system is in the used of imbedded microprocessors,
 179 which only allow for limited program instructions and an EPROM memory which is
 180 essentially a one time recording device until reset by other programming devices.

181 5. Other patents considered relevant are contained in the appendix:

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|-----|----|----------------|------------------|
| 182 | 1. | Ishigami | patent#5,311,430 |
| 183 | 2. | Camhi et al. | patent#5,430,432 |
| 184 | 3. | Yamawaki | patent#5,446,659 |
| 185 | 4. | Nishio | patent#5,541,590 |
| 186 | 5. | Woll et al. | patent#5,581,464 |
| 187 | 6. | Cuddihy et al. | patent#5,608,629 |
| 188 | 7. | Kikinis | patent#5,815,093 |

189 None of these devices, however, do an adequate job of provided relevant
 190 information as it relates to a vehicle accident in a comprehensive self contained cost

191 effective modular format. Neither do any of the prior inventions provide an electronic
192 means of vehicle identification, or a real world date and time of accident system. The
193 prior inventions also fail to provide a means of instant on scene access to the stored
194 data in a non-destructive way. The prior inventions also fail to provide for an internal
195 backup rechargeable battery power source necessary to prevent loss of data prior to
196 transfer to the non-volatile memory.

197 SUMMARY OF THE INVENTION

198 It is therefore an object of this invention to provide for a novel and improved
199 method and means for measuring and recording vehicle performance characteristics.

200 It is a further object of this invention to provide a novel and improved cost
201 effective method and means of measuring and recording vehicle status prior to,
202 during, and subsequent to a trigger event, which will be accurate and reliable, easy to
203 install, and can be retrofitted to existing vehicles.

204 It is a further object of this invention to provide a novel and improved self-
205 contained rechargeable power source for the purpose of completing the file routine
206 and transferring same to a non-volatile memory device if a power interruption occurs
207 either through cessation of vehicle operation by operator action or the occurrence of a
208 trigger event that disrupts the vehicle electrical system.

209 It is another object of this invention to provide a novel and improved method
210 and means of determining vehicle direction at all times.

211 It is a further object of this invention to provide a novel and improved method
212 and means of correlating all discrete events in relation to actual date and time of
213 occurrence and recording same.

214 Another object of this invention is to provide a novel and improved method
215 and means of identifying and storing vehicle specific data files by correlating and
216 incorporating the vehicle identification number in all files.

217 Another object of this invention is to provide for a novel and improved

218 method and means of identifying either a side to side, or front to back vehicle rollover
 219 through the coordinating and comparing the data from the tilt meter and the
 220 electronic compass. A side to side rollover would be indicated by activation of the tilt
 221 meter without significant change in the compass heading readings. A front to back
 222 rollover would be indicated by activation of the tilt meter coupled with a 180 degree
 223 compass flip.

224 DR BRIEF DESCRIPTION OF THE DRAWINGS

225 This invention can be understood and is described in greater detail by
 226 reference to and in connection with the accompanying drawings.

227 FIG. 1 is a functional block diagram showing one embodiment of a vehicle data
 228 recorder's power distribution.

229 FIG. 2 is a functional block diagram showing one embodiment of a vehicle data
 230 recorder's logic and data flow.

231 FIG. 3 is a combination functional block diagram showing both power distribution
 232 and data flow.

233 FIG. 4 is an operational flow chart showing one embodiment of a vehicle data
 234 recorder's sequence of operation.

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236 DE DETAILED DESCRIPTION OF THE INVENTION

237 The vehicle data recorder hereinafter referred to as the "VDR" will monitor
 238 four operational inputs from the vehicle and four event triggered inputs contained in
 239 the modular unit on eight data channels. All data channels will interface with CPU 6
 240 through the I/O card 5

241 1. Data channel one 18 will monitor the transmission. If the transmission is in
 242 park, a 0 volt state, the system will stay in standby and not record any data.
 243 If the transmission is in reverse, the system will go into a record data mode
 244 and sample the vehicle speed times a negative 1 multiplier. If the

transmission is in a forward gear, the system will go into a record data mode and sample vehicle speed without the negative multiplier. The transmission monitor will consist of an electrical connection to the indicator lights located on the drivers instrument array. Park will be indicated by a negative voltage, reverse by a positive voltage, and all other gears by a zero voltage state. In this manner, the system will know ^{whether} weather to be in stand-by, apply the negative multiplier to the vehicle speed, and simply record the speed data as read.

2. Data channel two will be connected to the speedometer. ¹⁵
3. Data channel three will be connected to the seatbelt indicator light. ¹⁷ When the seatbelt is not fastened, the indicator will provide a positive voltage to the data channel. When the seatbelts are fastened, the light will be out and no voltage will be supplied to the data channel.
4. Data channel four will be connected to the brake lights. ¹⁶ When the brake is applied, a positive voltage will be supplied to the data channel. When brakes are not used there is no voltage supplied to the data channel.
5. Data channel five is connected to an internal accelerometer ⁷ oriented to the front and rear of the vehicle. This accelerometer can register a +/- 50 gravity impact on an analog scale.
6. Data channel six is connected to an accelerometer ⁸ oriented to the right and left of the vehicle. This accelerometer can register a +/- 50 gravity impact on an analog scale.
7. Data channel seven is an internally mounted normally open tilt meter ⁹ that closes only after reaching or exceeding a 90 degree platform tilt.
8. Data channel eight is connected to an internally mounted electronic compass ¹¹ that provides a constant analog input to indicate the direction of the vehicle.

The data collected will be interfaced with the system through an internal input/output card 5 that will transfer the data to the central processing unit 6 where it will then be recorded to active memory. The active memory will be capable of recording at least 20 minutes of vehicle operation. When the active memory reads full, the cpu 6 will create a unique file based upon the date and time as supplied by the system clock, and transfer that file to a non volatile cache memory, erase the active memory and begin recording new data. When a power interruption occurs for any reason, or the vehicle transmission is placed in park, or an impact or rollover occurs the system will record data for an additional 30 seconds, then the cpu 6 will create a unique file based upon the date, time, and vehicle identification number and transfer that file containing all pertinent data to permanent memory 10 where it will be available for download. To accomplish the data transfer, the system is provided with a battery backup. 4

THEORY OF OPERATION

The operational sequence of the VDR can best be understood by reference too and in connection with the logic flow chart provided in figure 4.

When the vehicle is started, 12VDC 1 is supplied to the VDR through the vehicle ignition 2 to both the DC to DC converter 3 and the battery charger 4. The DC to DC converter changes the 12VDC from the vehicles electrical system to a regulated 5VDC and distributes the power throughout the system. The system BIOS contained in the boot section of the CPU 6 performs a series of built in self tests to insure that the system is working, If the system fails any of these tests, an indicator light 14 will be illuminated on the vehicle dashboard as a visual reminder for service.

After successful completion of the self test, the VDR will enter a standby state until the vehicle is taken out of park. If the vehicle is in a reverse gear, the speed will be recorded as a negative number. If the transmission is in any of the forward gears or neutral, the system will record a positive speed. When the vehicle is placed in gear,

299 The VDR will:

- 300 1. Inquire and record the time and date.
- 301 2. Check and record the speedometer using a negative multiplier if required.
- 302 3. Check and record the vehicle direction.
- 303 4. Check and record the seatbelt indicator.
- 304 5. Check if the front/rear accelerometer has triggered an impact greater then the
- 305 specified threshold level. If yes, the system will compare the recordings of the
- 306 front/rear accelerometer to the left/right accelerometer. If the front/rear
- 307 accelerometer has an impact greater then the left/right accelerometer, the VDR
- 308 will check to see if the tilt meter has recorded an event greater than 90
- 309 degrees.
- 310 6. If the front/rear accelerometer has not triggered, the VDR will sample the
- 311 left/right accelerometer and make the same comparisons. The logic loop, as
- 312 illustrated in the figure ²⁾₃₎ explains how the VDR decides what type of event has
- 313 occurred.
- 314 7. Check and record the brake.
- 315 8. Write to memory. If memory is full, download file to memory routine.
- 316 9. Check power and transmission. If in park or ignition is turned off the VDR
- 317 will download the active memory to the file routine.
- 318 10. Start over.

319 From the foregoing, it will be greatly appreciated that a novel and improved

320 inexpensive self-contained vehicle data recorder has been devised wherein the

321 magnitude and direction of the kinetic forces that act upon a vehicle during the

322 occurrence of an accident can be recorded to memory and accessed at the scene of

323 that accident for the beneficial use of the vehicle passengers^{and/or rescue personnel}. These forces and

324 measurements include but are not limited to the speed of the vehicle, the direction of

325 the vehicle, the angular forces that result from either a side or front or rear impact,

the deceleration forces (g-forces) that result from said impact, the brake activation, seat belt use and the centrifugal forces that result from either a rollover or spin. Instant access to this vital information allows EMS personnel to provide a more focused exam and treatment of accident victims while preserving the information coded with the, Date and Time of the accident and the vehicle identification number for the police report and the subsequent analysis of the accident. It should be understood that transmission of the electronic accident report to and collection by the state and federal agencies would provide a comprehensive data base on vehicle accidents that could be used as the basis for devising better and safer vehicles. We would know for instance the exact time of day that most accidents occur. This would be helpful in allocating police, EMS, and medical manpower in a more cost effective way. We would know the exact speed at which most accidents occur, we would have a permanent vehicle accident record that would be available to anyone with access to the internet.

It is therefore to be understood that various modifications and changes may be made in the method and means and apparatus of the present invention, as well as its' intended application and use without departing from the spirit and scope of the present invention as defined by the following claims.

I claim:

1. A self-contained method and apparatus for the detecting and recording of vehicle operating systems data and vehicle response to the kinetic forces that act upon the vehicle during an accident trigger event consisting of;
 - A plurality of electrical connections for collecting pertinent data on various vehicle systems, such data in one preferred embodiment consisting of the speed of the vehicle, seat belt use, forward of reverse gear status and brake activation, said signals being in part analog, and in part digital.
 - A. A multistage memory scheme consisting of a short term active memory capable

of retaining a short time segment of operational data, a second stage cache memory to temporarily store the data transferred from the active memory during the re-write cycle, and a non-volatile memory capable of storing data for periods of up to 30 days or more.

2. A self-contained method and apparatus for the detecting and recording of vehicle operating system data as claimed in claim 1 wherein said apparatus contains a re-chargeable back-up battery system for the purpose of completing the transfer to permanent file the operating data collected by the recording system in the event of the interruption of the host vehicle electrical system either through the occurrence of an accident trigger event, or operator action.

3. A self contained method and apparatus for the detecting and recording of vehicle operating systems as claimed in claim 1 consisting of a magnetometer device to provide a constant signal used to determine at all times the vehicle direction.

4. A self contained method and apparatus for the detecting and recording of vehicle operating systems as claimed in claim 1 consisting of the means of detecting and recording vehicle rollover consisting of a normally open tilt meter that would close only after the host platform or vehicle would reach or exceed a 90 degree tilt.

5. A means of determining what type of vehicle rollover had occurred by using the output of the magnetometer as claimed in claim 3, and the output of the tilt meter as claimed in claim 4 to decide if a front to back rollover, a side to side rollover, or a vehicle spin had occurred with

a. a vehicle spin being indicated by the rapid change in vehicle heading with out activation of the tilt meter, and

b. a side to side rollover being indicated by activation of the tilt meter without the corresponding change in vehicle heading, and

c. a front to back rollover being indicated by activation of the tilt meter with a corresponding 180 degree change in vehicle heading.

380 6. A method and means to download and access the data recorded on the
381 recording device as claimed in claim 1 to any hand held or portable computing device
382 consisting of a readily accessible series connector and the means and power source to
383 activate the stored memory for the purpose of the file transfer, and the mean to view
384 the transferred file in any computing device.

ADD
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